

Pulses & rhythms

Analysing volatility, cyclicality and the cobweb phenomenon in prices



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Reading the pulse

5%

Share of spend on pulses in total household food expenditure in India

82%

Unirrigated area under pulses production in India

6%

Per year growth in pulses production in last 12 years

12%

Average inflation in pulses prices in last 12 years

Gram

An outlier with higher profitability, high inflation and growing exports

22.95 MT

Pulses produced in India in 2016-17; 40% higher than previous year and 19% higher than previous record production of 19 million tonne (MT) in 2013-14

23%

Deflation in pulses so far this fiscal; price decline this year steepest in 12 years

16%

Fall in profit margins per quintal for an average pulses grower agriculture year 2016-17

Executive summary

That prices of pulses are highly erratic is common knowledge. What is not commonly known, however, is that there is a method to this madness.

CRISIL has observed that inflation in pulses, as measured by the wholesale price index (WPI), follows a cyclical pattern, with prices shooting up every 2-3 years. Between fiscal 2006 and so far in fiscal 2018, there have been as many as four such cycles. The trend rate of inflation has averaged 12.2%, with the peaks 40% above the zero level and the troughs 25% below it.

The latest cycle, which began in fiscal 2013, has been a little different from the earlier cycles. Not only has it witnessed the steepest peak (49% in November 2015) and fall (-32.6% in July 2017), but also, it has seen broad-based (across pulses) price fluctuations compared with the previous cycles where inflation was driven by individual categories of pulses.

What gives? A closer look at the pulses inflation data throws up two broad themes:

First, upon decomposing the data for the past 12 years, we observe that gram (chickpeas) and tur/arhar (pigeon peas) have experienced high price volatility and dominated the cyclical price movements in pulses in the past 6 years, compared with urad, moong and masur. Further, de-seasonalising and de-trending the data shows that while almost all pulses are prone to seasonal price cycles, these are more pronounced in the case of gram and urad (prices begin to dip in June and pick up in October).

Second, there is a cobweb phenomenon at play, wherein production responds to prices with a lag, causing a recurring cycle of rise and fall in output and prices. Upon analysing the correlation between production and one-year lagged WPI inflation data for the past 12 years, we find that the price cycles have been generally triggered by positive (excess production) and negative (under production) supply shocks. This has to do with the fact that farmers base their sowing decisions on the prices observed in the previous period, and accordingly over- or under-produce the crops, triggering a price cyclicity.

Whatever the reason, any decline in pulses prices impacts the farmer as it erodes profitability.

In agriculture year 2016-17, profit margins of all pulses except gram declined an average 30%. The year saw record-high pulses production. However, restrictions on export and private stockholding reduced avenues for absorption of excess supply. The dent in domestic consumption demand caused by demonetisation may have further contributed to the decline in prices. Despite an increase in minimum support price, or MSP, and government procurement of pulses, wholesale prices of all pulses except gram declined, while input costs continued to grow.

But what helped gram, which has a high share of 40-45% in production and over 60% in exports of pulses, buck the trend? While the prices of most other pulses fell in the past 6 years, the price of gram has shot up. Indeed, the steepest peak seen in the recent price cycle was mainly on account of gram, which witnessed a sharp rise in both MSP and international prices.

This is intriguing, but the answer is not far to seek. In gram's case, the cobweb phenomenon appears to be more prominent for international prices than domestic prices. Since there is no restriction on the export of gram, profitability remained higher for gram farmers as the international market was ready to absorb the supply in excess of the domestic demand.

Given this, CRISIL believes the government can tame the volatility in pulses to a fair extent. An alternative price smoothening mechanism could include steps such as:

1. **Effective MSP:** The government could raise procurement under the MSP scheme for pulses and focus on improving awareness among farmers for availing of it
2. **Open trade policy:** Flexibility in export policy, in terms of permitting exports of the restricted pulses in times of excess production, can provide adequate cushion against supply shocks
3. **Irrigation:** Since 82% of the area sown under pulses is unirrigated, the government can invest more in expanding water-conservation techniques such as drip and ferti-irrigation to reduce the farmers' dependence on monsoon for growing pulses
4. **Effective markets:**
 - a. Improving infrastructure – Development of roads, storage and transportation facilities can help reduce transportation costs for farmers
 - b. Futures market: Since forwards contracts help in reducing the uncertainty of future market prices, the government should promote futures and work towards increasing farmers' awareness of these.

Heart of current weakness

The current decline in pulses inflation is noteworthy for two reasons:

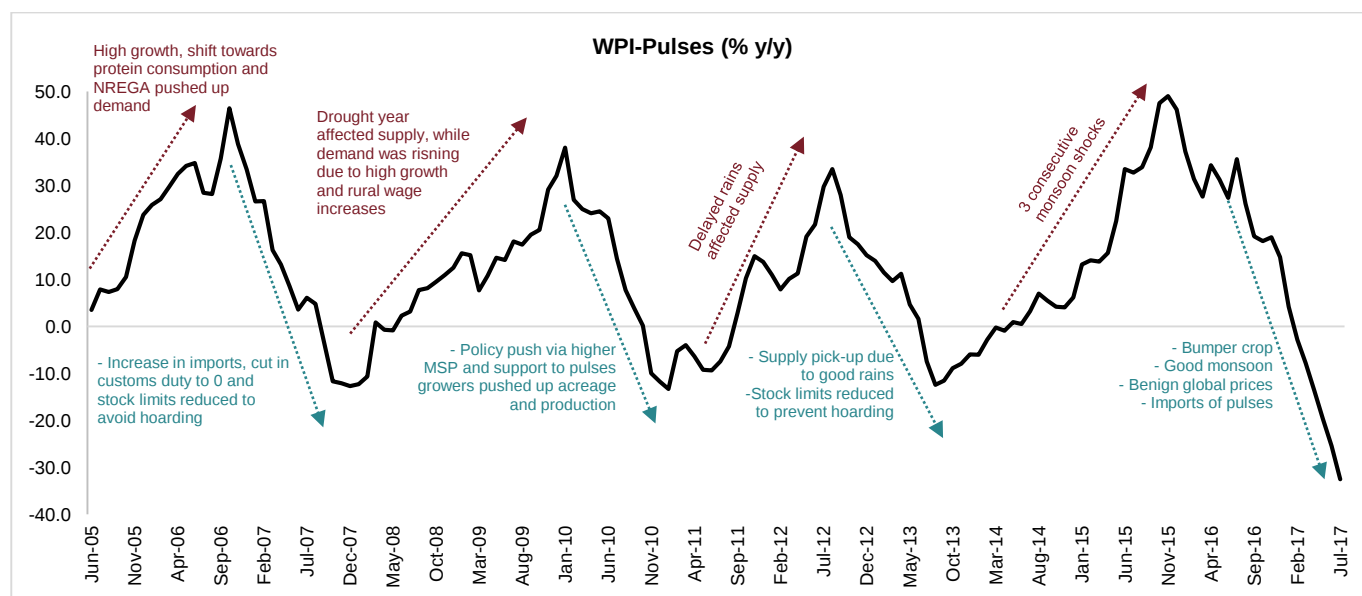
First, while the recent peak in pulses inflation was higher than the previous peak seen in 2006, the current dip has turned out to be the steepest in 12 years.

The trend rate of inflation for the observed series is 12.2% -- a level that has more or less held in both halves of the 12-year period, as corroborated by the high peaks on either side. Pulses inflation shows a tendency to peak each time there is a production shock. However, the extent of the dip is less, causing trend inflation to stay high and sticky. On average, the peaks have hovered 40 percentage points above the 'zero' level, while the dips are only 12-13 percentage points below.

The current dip is different, since more than half the price rise seen in the previous year has been wiped out.

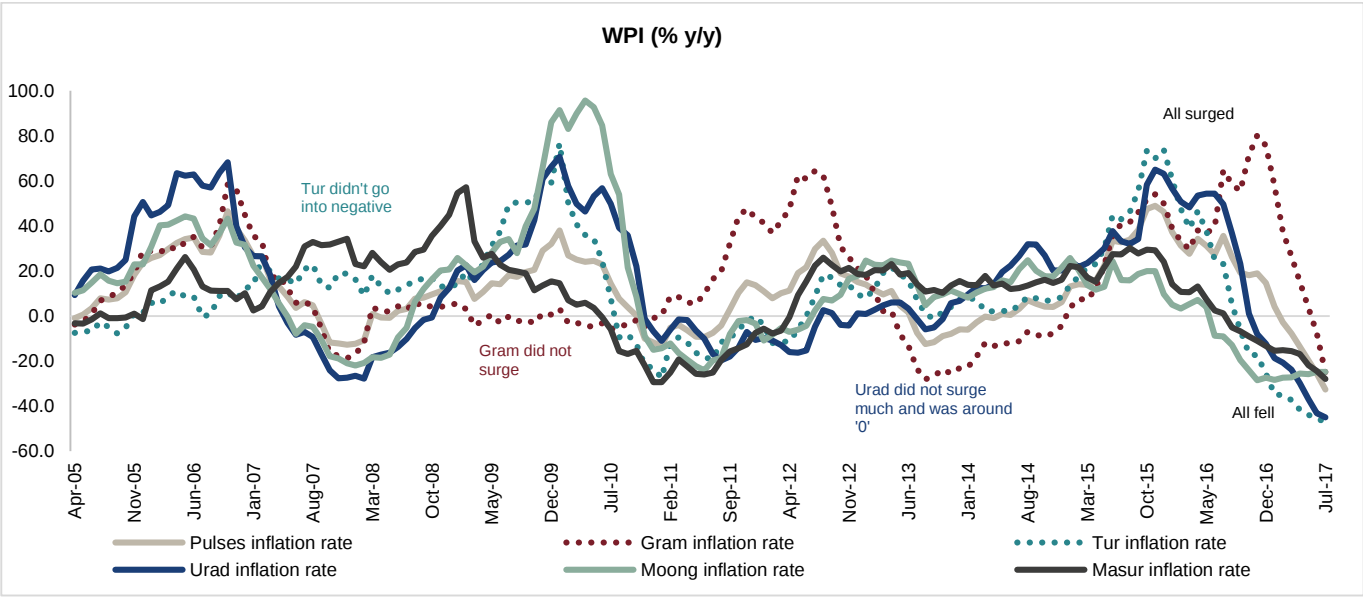
Second, in all the previous periods of sharp price spikes, individual pulses commodities led the price-fire. This time though, the price rise and the dip has been broad-based.

Catching fire every 2-3 years



Source: Ministry of Commerce and Industry, CEIC, CRISIL Research

A different pulse led every surge



Source: Ministry of Commerce and Industry, CEIC, CRISIL Research

Gram, tur and urad the heavyweights

Of the five main categories, gram, tur and urad have the highest weight in the wholesale price index (WPI) for pulses. Hence, price movements in these pulses can cause significant movement in the index. Moong and masur are important from a consumption demand perspective. Hence, all five have been included in the analysis.

Pulses and gram beat differently

In the past 12 years – and especially in the past six – gram as a category has seen the steepest increase in inflation, as well as higher volatility.

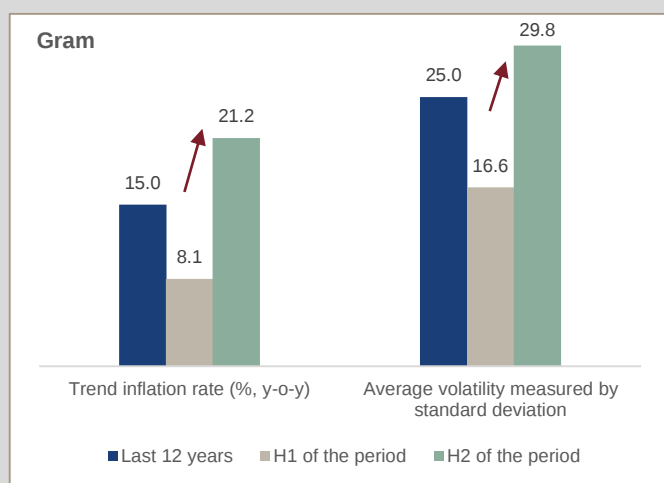
Production data shows gram now occupies a significant production as well as export share. Among other pulses items, volatility also rose in tur, but inflation trended down.

In gram and tur, correlation with the overall pulses index has increased significantly in the past six years. This means these two pulses have a larger role to play in influencing the overall pulses price index.

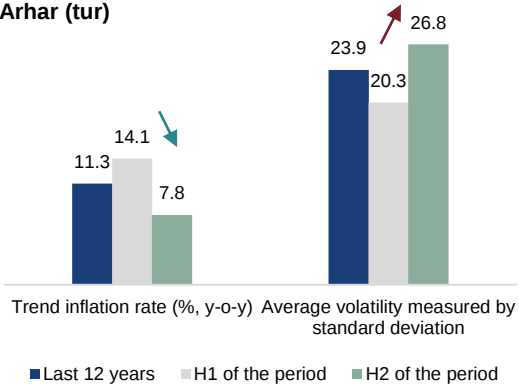
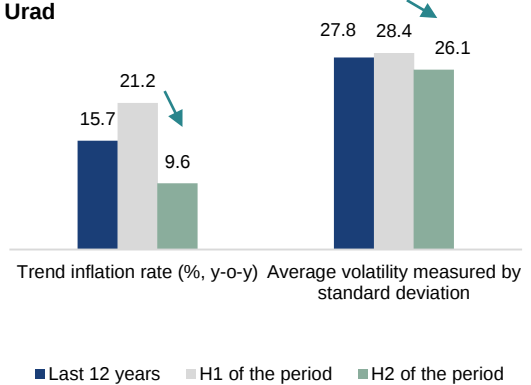
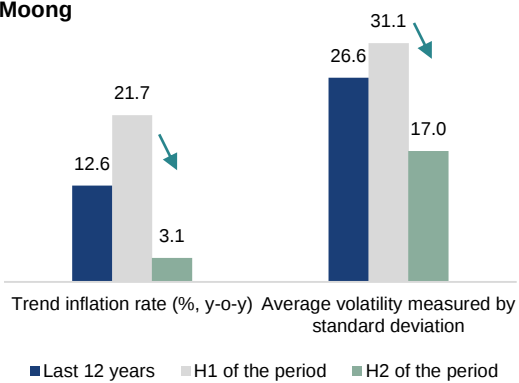
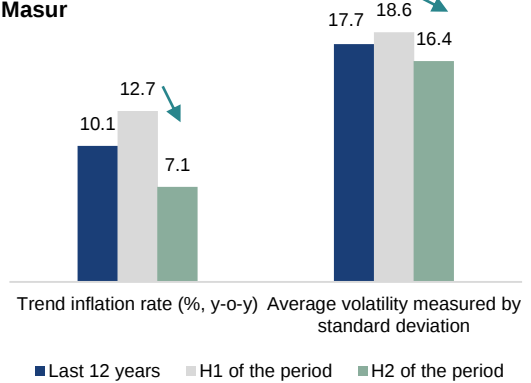
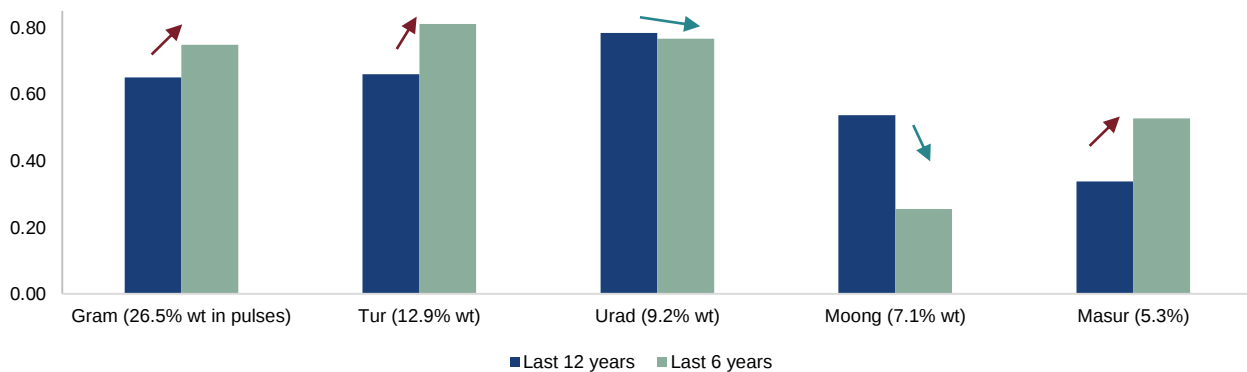
Price behaviour

To understand the price behaviour in pulses, we split the last 12 years to see which category now has a dominating influence in driving overall pulses inflation. The takeaways:

1. Overall inflation in pulses was more or less sticky at an average 12% in the past 12 years, though marginally lower in the past six years
2. In the past six years, both inflation and volatility in inflation trended down in urad, moong and masur. Even in tur, inflation trended down because of higher production and resort to imports, though volatility rose somewhat
3. Gram shows a completely contrasting behaviour. Both, inflation and volatility in inflation in gram trended up significantly in the past six years, causing overall pulses inflation to stay high
4. Inflation in gram and tur now has a much more significant influence on overall pulses inflation compared with other pulses items, as seen in the following correlation chart



- In the past 12 years, gram has seen the steepest increase in inflation as well as higher volatility in inflation rates, especially in the past 6 years.
- Average inflation in gram was ~21% during the past six years, up from ~8% in the preceding period.
- The increase has also been accompanied by a pronounced rise in volatility in gram inflation.
- Separately, data shows gram is also now an important produce with a production share of 40-45% in pulses (up from 39%, 12 years ago) and an export share of over 60%.

Arhar (tur)**Urad****Moong****Masur****Correlation in inflation rates**

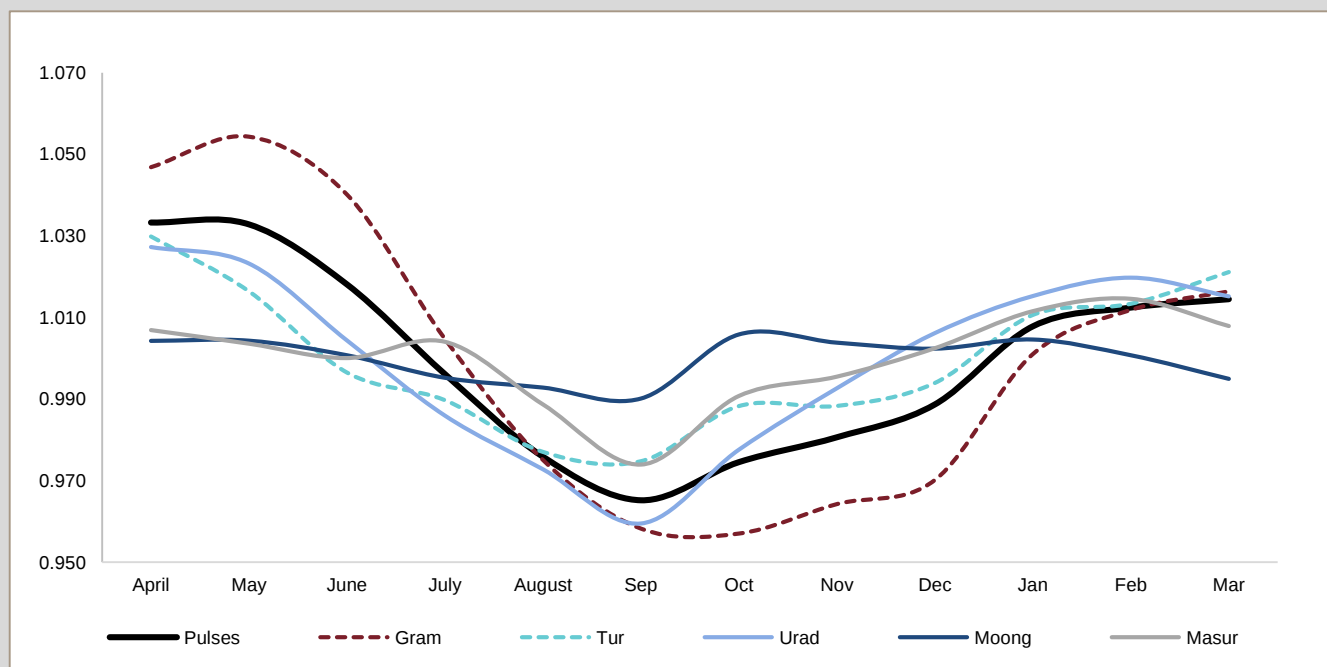
Source for all tables and charts above: Ministry of Commerce and Industry, CEIC, CRISIL Research

Decomposing price behaviour

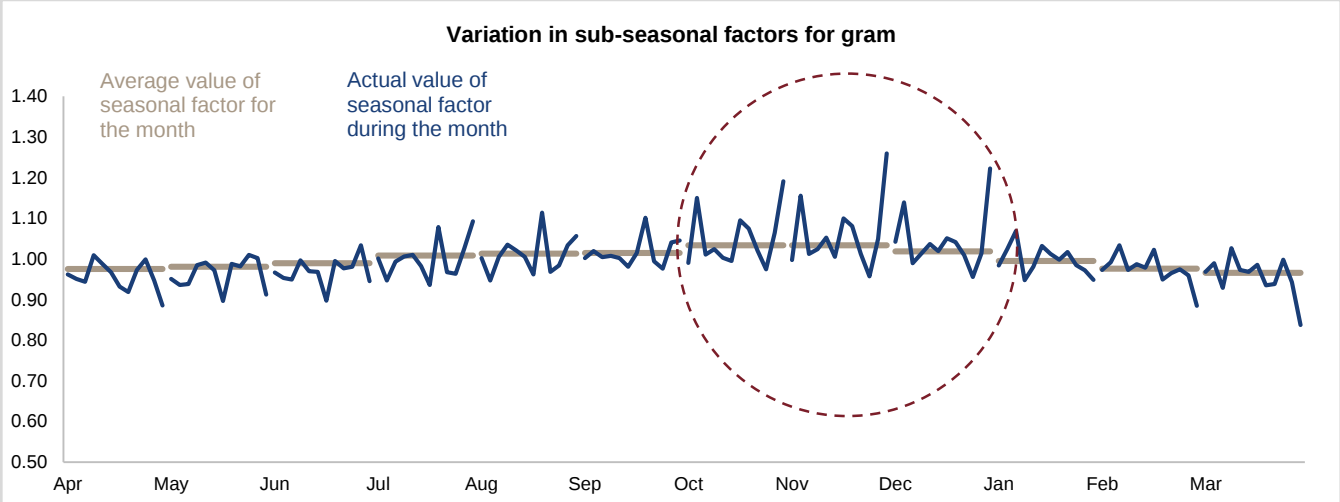
To understand the price behaviour across pulses categories, we decomposed the price index for each category into impact of seasonal factors and cyclical factors. We first de-seasonalised the data using a multiplicative model and then de-trended it to arrive at the cycles. The takeaways:

1. Seasonal factors are most pronounced in gram and urad. In gram, the price dip typically begins in June (when the rabi crop enters the market) and starts picking up in October. In case of tur, the seasonal movements are similar but less pronounced. The peaks and troughs are less sharp, possibly because production takes place in both kharif and rabi seasons.
2. A study of sub-seasonal variations suggests that volatility in prices is higher during November and December, as reflected in the fact that the average value of seasonal factor for these months is quite different from the actual values. A similar trend is observed for arhar (tur) in December and January, partially explaining the higher volatility in these two categories.
3. Almost all pulses categories are subject to price cyclicality, but the recent cycle saw the steepest climbs and dips. The cycles are more pronounced in gram, urad and moong and closely trace the cycle in overall pulses. The sharp upturn and fall in prices in the recent period was, however, common to all.

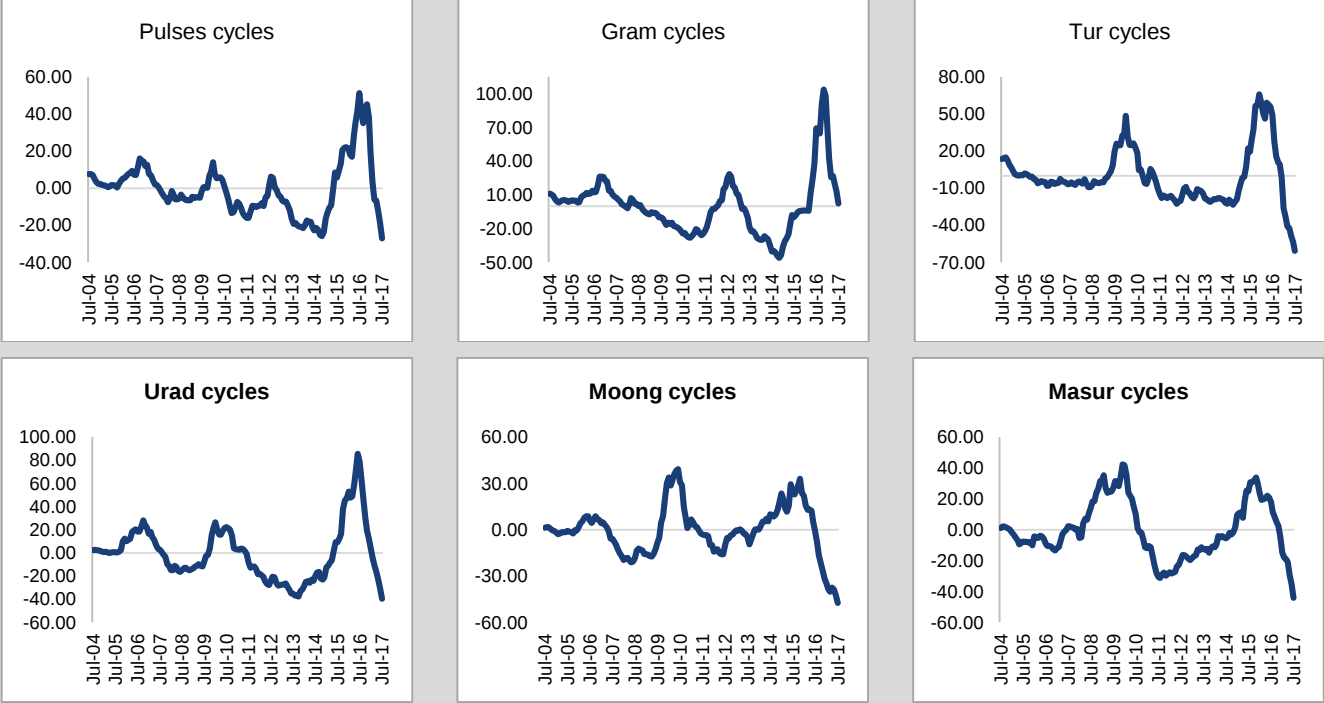
Seasonal movements in the WPI



Sub-seasonal volatility in seasonal price indices



Almost all pulses are prone to price cycles



Source for all tables and charts above: CSO, CEIC, CRISIL Research

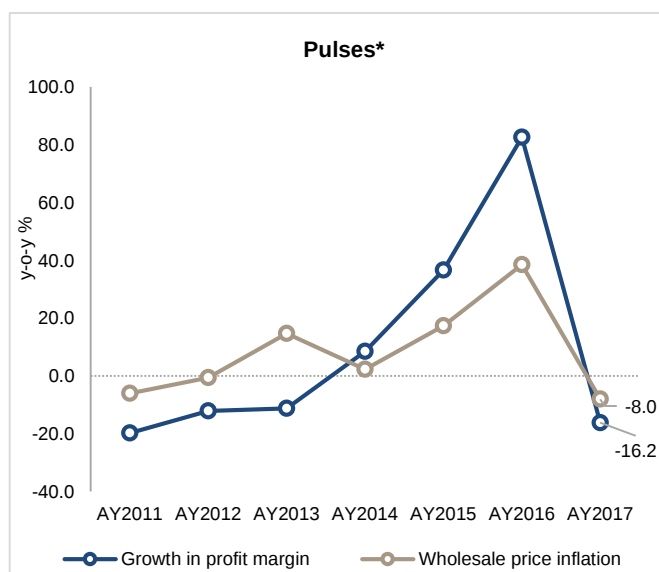
Prolonging farm distress

We have seen how the recent fall in pulses inflation stands out for its severity, as well as for being broad-based. However, while it has brought relief to consumers, it has also brought on another kind of crisis.

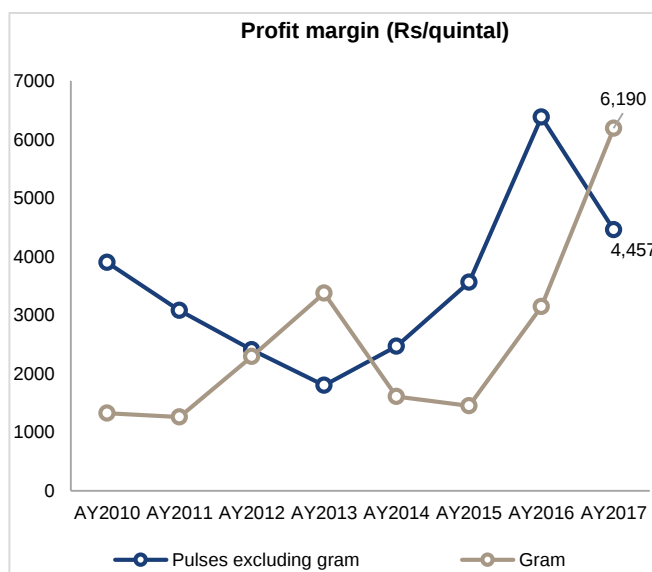
Profitability of pulses production, as gauged by average profit margin per quintal across five pulses¹, declined 16.2% on-year in agriculture year (AY) 2016-17 (or, July 2016 to June 2017), due to the sharp fall in wholesale prices. Note that this profitability is derived by taking wholesale prices as the selling price of pulses. The actual profit margin accruing to the farmer would be even lower, since he generally receives a price lower than the wholesale price at which the crop trades in mandis.

The decline in profitability in pulses is sharper if we remove the impact of gram, where profits continued to rise in AY 2016-17 in line with rising wholesale prices. Except gram, profit margins of all pulses declined on average by 30.1% on-year.

Fall in selling price squeezed profit margins in pulses



Profit margins declined for all pulses except gram



Note: Profit margin is defined as profit per quintal, *Data used for pulses is average of corresponding figures for tur, moong, urad, gram, and masur

Source: Department of Agriculture, Cooperation and Farmers welfare (DAC&FW), Department of Consumer Affairs (DCA)

While the selling price of pulses fell, the cost of cultivation continued to rise. Cost of cultivation, as gauged by 'C2'² measure of Commission for Agricultural Costs and Prices (CACP), increased 3.7% on-year in AY 2016-17, compared with 2.8% in the previous year. This further reduced the profitability of pulses.

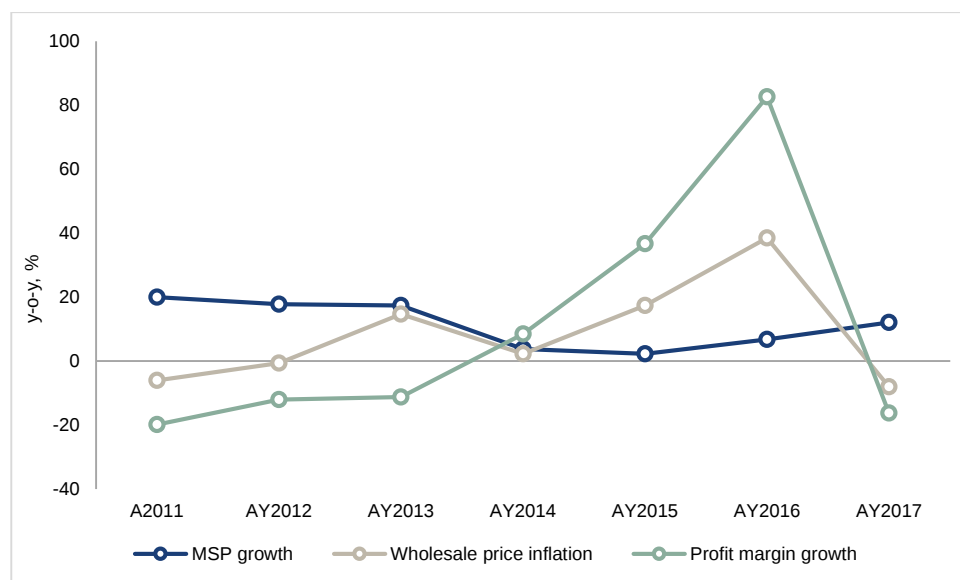
In this scenario, increase in MSPs did little to stem the fall. While the government had hiked MSP of the five pulses by an average 12% on-year in AY 2016-17, the wholesale prices of pulses except gram declined 8%. Prices even

¹ Profit margin is obtained by subtracting cost per quintal from wholesale price per quintal of the given crop. The pulses considered are: tur, moong, urad, gram and masur

² C2 measure includes the actual paid out costs (eg, seeds, fertilisers, irrigation charges) plus imputed value of family labour, rent and interest on owned land and capital.

fell below the MSP for arhar (tur) and moong during the harvest season in 2017 owing to a bumper crop and cheaper imports. Between October 2016 and February 2017, modal prices of arhar and moong were trading below MSP in major APMC³ mandis of Karnataka, Maharashtra and Telangana.

Market prices, profit margins fell despite higher MSP in AY2017



Note: Growth rate is computed on profit margin per quintal

Source: CACP, DAC&FW, DCA

Analysing the latest fall

Several factors have contributed to the decline in the prices of pulses. These include:

Supply-side factors

- **Record high sowing and production:** Incentivised by high growth in selling prices and significant increases in MSPs of pulses in the past two years, farmers increased the area sown under pulses to a record-high of 29 million hectares in AY 2016-2017. This was a 16.2% expansion over the previous year. Good monsoons further led to a record production of 22.95 million tonnes; a growth of 40.4% on-year.

Demand-side factors

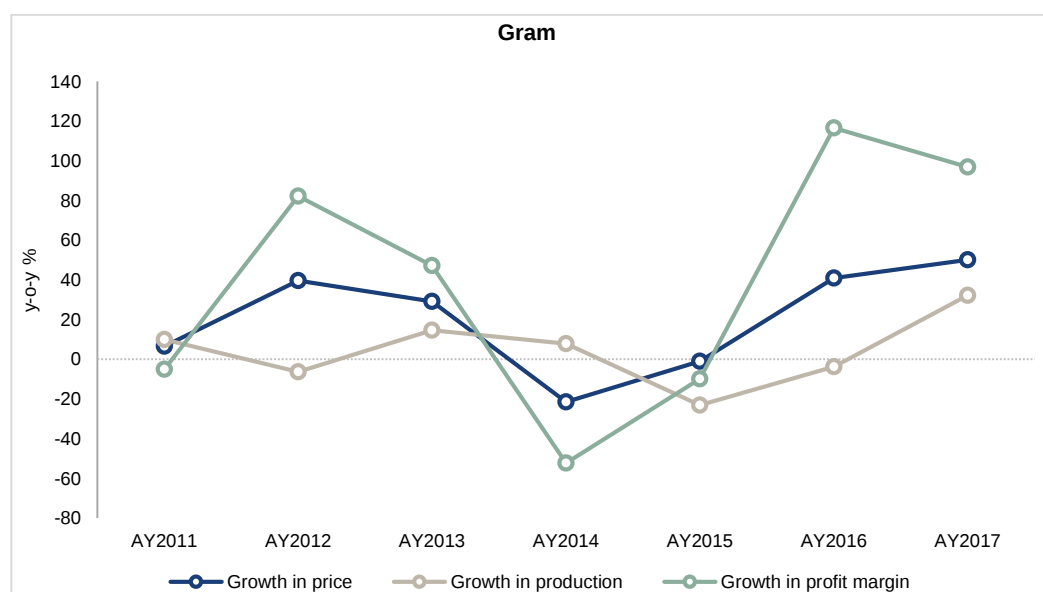
- **Demonetisation impact:** Agriculture is a highly cash-intensive economy and the cash crunch in the immediate aftermath of demonetisation disrupted supply chains in the sector. The shortage of cash also hit domestic consumption demand. In January-March 2017 (i.e., the months following demonetisation announcement in November), private final consumption expenditure growth decelerated to 7.3% on-year, from 11.1% in the previous quarter. This dent in demand, coupled with bumper production of pulses, may have further led to a fall in prices.

³ Agricultural Produce Marketing Committee

Policy-induced factors

- **Unfavourable trade policies:** India's international trade policies did not help in easing the excess supply of pulses. While exports of all pulses, except gram, were restricted to a maximum 50,000 tonnes per annum, there were no restrictions on imports. Even though there was a record-high pulses production, lower international prices induced imports of 6.6 million tonnes in 2016-2017, 14% higher on-year. On the other side, exports fell 0.5% to 0.14 million tonnes. This exacerbated the excess supply in the domestic economy and led to a fall in prices.
- It is interesting to note that gram, which has no export restrictions, was the only crop to witness a rise in prices and profitability. Wholesale prices of gram increased 50.1% on-year in AY 2016-17, compared with 40.9% in the previous year. Profit margins of gram almost doubled on-year.

Gram the lone warrior



Note: Profit margin is defined as profit per quintal

Source: DAC&FW, DCA

- **Private stock-holding restrictions:** In October 2015, the Centre brought pulses under the Essential Commodities Act, 1955, to prevent hoarding of pulses. This empowered states to impose stock limits on pulses sourced from importers, held by exporters, licensed food processors, and large departmental retailers. These limits continued in 2016-17, which further reduced avenues for absorption of excess supply. Although the Centre directed the states to remove stock-holding limits in May 2017, it came belatedly, after the peak arrival period was already over.
- **Limited support from government procurement:** The government tried to ease excess supply by ramping up procurement of pulses to 1.1 million tonnes in 2016-17 from 46,000 tonnes in 2015-16. However, this was insufficient to arrest falling prices, given the stock holding limits and export restrictions.

Hence, in a year of bumper crop, farmers suffered a decline in profitability. Increase in MSPs and government procurement were insufficient to arrest falling prices. For some months, wholesale prices of pulses fell even below the MSPs, which were supposed to act as floors. Had the government altered international trade and domestic policies in line with demand-supply conditions prevailing in the economy, prices might not have fallen so much.

The government needs to protect farmers from a rapid fall in prices in years of bumper production, just as it proactively manages the risk of a rapid rise in prices to protect consumers in years of low production.

Caught in the cobweb

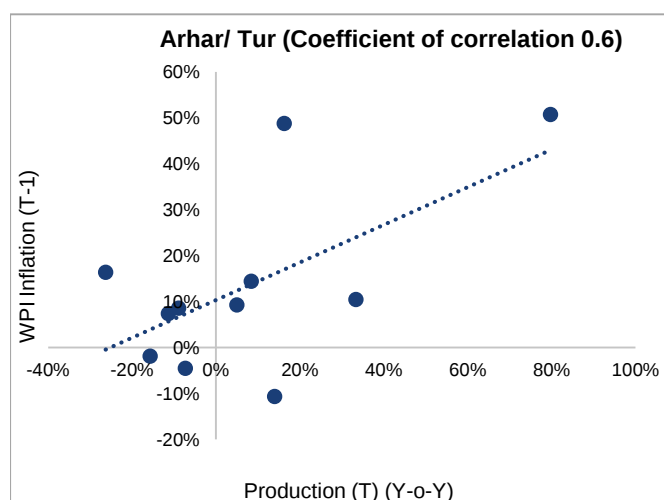
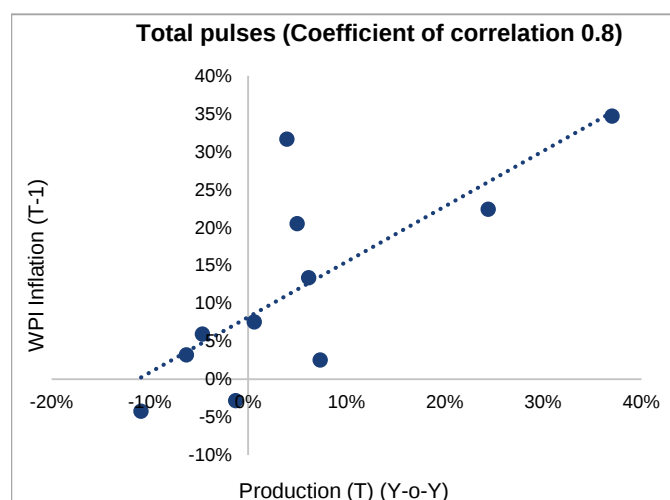
Besides the inherent risks of weather and pests, production of agricultural commodities assumes a large price risk. The time lag between sowing and harvesting of crop implies an inter-temporal relationship between production and prices of pulses. Farmers base their sowing decisions on prices witnessed in the previous marketing period. So, if the farmer observes a higher price for a specific crop in period ' $t-1$ ', he would opt to produce more (and hence sow more) of it in period ' t '. However, if the production of the crop exceeds market demand, prices fall in period ' t ', signalling farmers to produce (sow) less of the commodity in period ' $t+1$ '. This pattern is termed as a cobweb phenomenon⁴ which occurs in markets where there is a time-lag between demand and supply decisions. To put it in a simplistic equation, the cobweb phenomenon would imply:

$$\uparrow (P_{t-1}) \Rightarrow \uparrow (Q_t) \Rightarrow \downarrow (P_t) \Rightarrow \downarrow (Q_{t+1}) \Rightarrow \uparrow (P_{t+1}) \Rightarrow$$

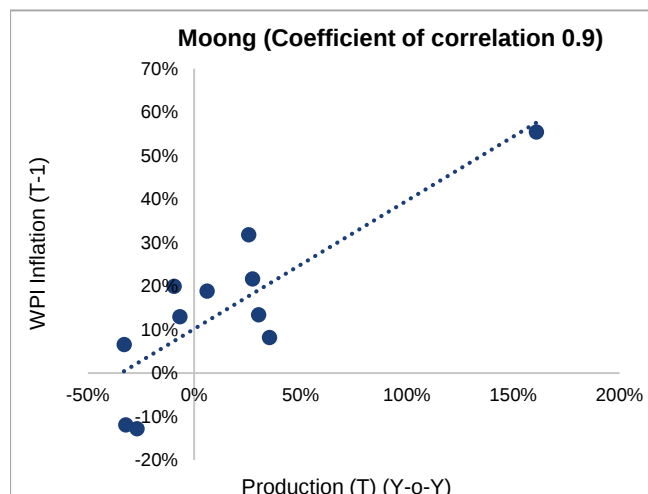
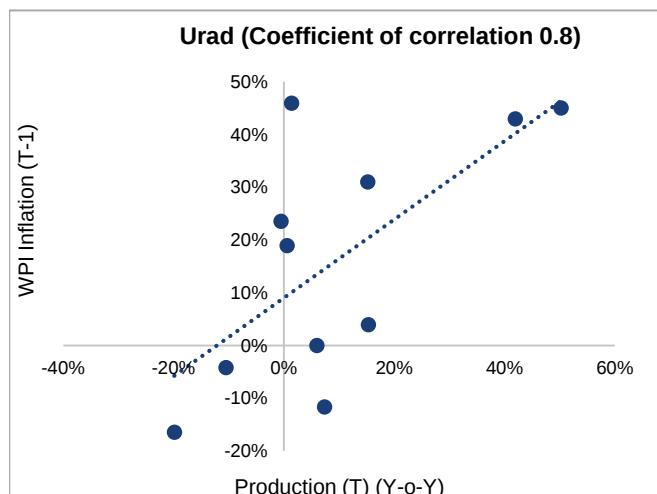
A prominent cobweb pattern has been observed in pulses since the AY 2010-11 (July 2010 to June 2011), when changing dietary patterns favouring proteins made pulses popular as a cheaper source of protein compared with egg, poultry, meat and dairy products.

Upon analysing production growth and the WPI inflation data with a one-year lag between 2006-07 and 2016-17, we observed a positive correlation between the two, especially in the case of tur (arhar), urad and moong.

Positive correlation between one-year lagged WPI inflation and production growth for pulses



⁴ Depending on the elasticity of the demand and the supply curve, the fluctuations in prices and production would perpetually continue, or converge to or diverge from the equilibrium, thus creating a cobweb like pattern around the two curves. If the demand and supply curves have similar elasticity, then the prices and production would continuously fluctuate. If the demand curve is relatively more elastic than the supply curve, the fluctuations may eventually converge to an equilibrium. However, if the demand curve is relatively inelastic compared with the supply curve, the fluctuations may diverge away from the equilibrium.

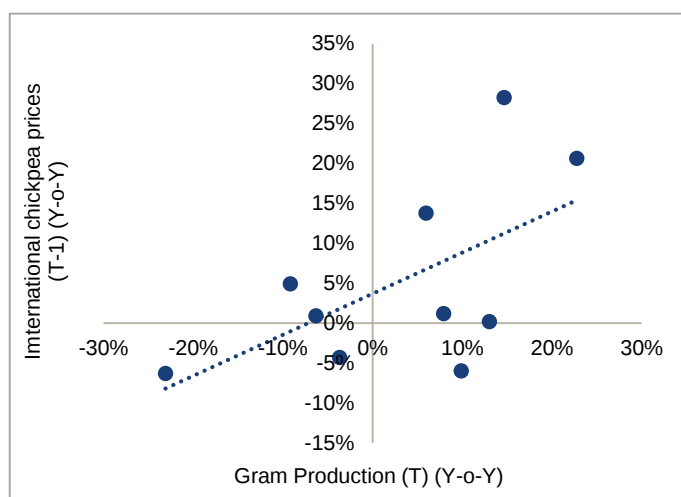
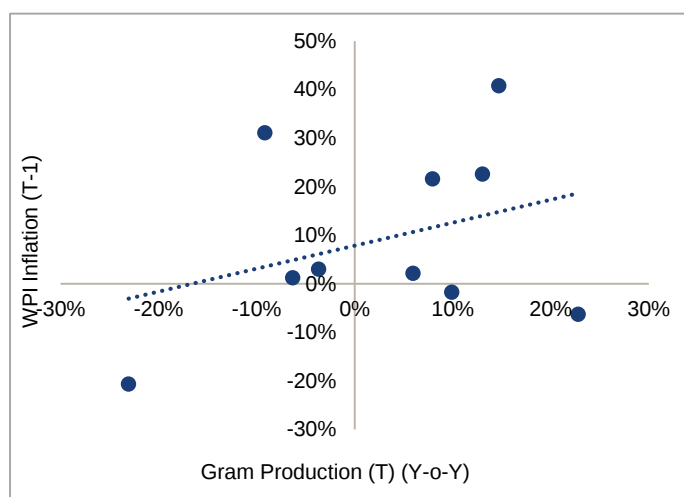


Source: CEIC, Ministry of Commerce and Industry, DAC&FW

In the case of gram, however, a cobweb phenomenon is more prominent for international rather than domestic prices. While there exists a weak positive correlation (coefficient of correlation = 0.3) between production growth and lagged WPI inflation, a strong positive correlation (coefficient of correlation = 0.6) is witnessed between production growth and international prices of gram. The stronger correlation with international prices in case of gram could be attributed to the absence of trade restrictions in the export of gram.

Weak positive correlation (0.3) between WPI inflation and domestic production growth

Strong positive correlation (0.6) between global prices and domestic production growth



Source: CEIC, Ministry of Commerce and Industry, DAC&FW, Food & Agriculture Organisation of the United Nations (FAO)

The prevalence of the cobweb phenomenon in pulses despite the presence of a price smoothing mechanism of MSP in place, raises questions on the adequacy and efficiency of this market intervention mechanism. It has been argued that during times of over production and a global fall in prices, farmers of pulses are forced to sell their output at prices below MSP, given the perishable nature of the crop.

A popular suggestion is to get the government to increase procurement of pulses. However, we suggest alternative price smoothing mechanism to ease price volatility in pulses in the subsequent section.

Stabilising the pulses rates

Farm incomes remain stressed, given the volatility in prices and declining realisations. For commodities such as rice and wheat, the relative effectiveness of procurement tends to smoothen prices. This is because the MSP prices act as price signals and procurement is effective. In pulses, however, although MSPs are announced, procurement remains relatively weak.

A few other mechanisms are in action –supply of high yielding variety seeds to ensure better yields, a price stabilisation scheme, and openness to external trade. However, the effectiveness of these tools is weak, as is evident from the erratic price behaviour this year. Despite a bumper crop in 2016-17, procurement of pulses was sub-par. With global prices being lower as against domestic prices, the government imported over 6 million tonnes of pulses through the price stabilisation scheme designed for pulses. As a result, prices of pulses collapsed.

We look at some of the steps that could work as an alternative price smoothing mechanism for Indian pulses farmers.

Making MSPs effective

Although 23 crops are covered by MSP, only wheat and rice benefit from effective procurement. Therefore, the government could raise procurement under the MSP scheme to make it effective. In addition to improve procurement infrastructure, focus on awareness of and accessibility to government agencies procuring crops is a must. The price stabilisation fund could be used to improve procurement infrastructure. This should be the priority of the government till infrastructure and markets for agricultural products develop.

Open trade policy

The government has prohibited exports of pulses, except gram and organic pulses⁵, since June 2006. The restriction, which was supposed to be valid for six months, has been extended from time to time, with the last extension order in March 2014. The case of gram has showed that the international market can absorb production in excess of domestic demand when such exports are permitted. Therefore, flexibility in export policy, in terms of permitting exports of the restricted pulses during times of excess production, is crucial for providing adequate cushion, particularly against supply shocks.

Irrigation

About 82% of pulses grown in India lack irrigation facilities, making them vulnerable to the vagaries of the monsoon. Although investment in agriculture has grown, government investment has declined in the past few years. Moreover, most irrigation projects by the government since 2004 have been delayed or remain incomplete. Therefore, the government should invest more in expanding water conserving techniques such as drip and ferti-irrigation.

Effective markets

Most farmers sell their products below MSP owing to lack of transportation. Long distances between mandis and villages force farmers to sell products locally at low prices. Therefore, the government should help reduce transportation costs for farmers by linking them via better roads. Moreover, it should invest in the development of storage and transportation facilities, which are 50% less than required levels.

Futures markets

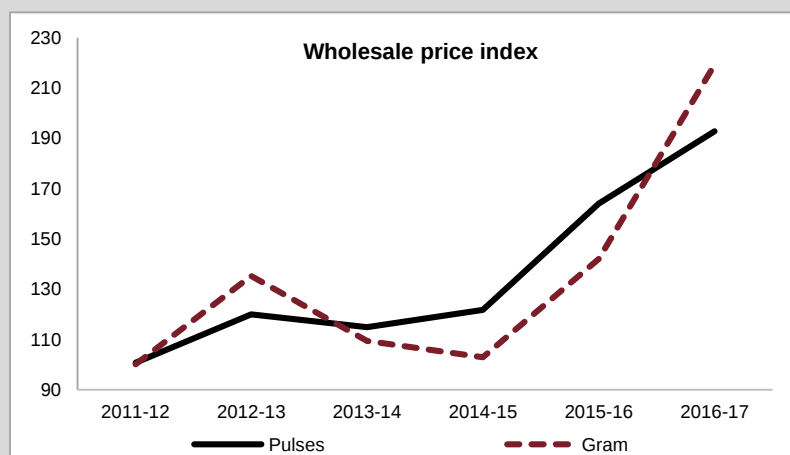
Forward contracts help reduce the uncertainty of future market prices. The government can use future market signals to fix MSP values and make appropriate interventions before crises occur. The farmers can then make their decisions on the basis of expected prices (and not on cobweb phenomenon) Therefore, governments should increase the level of awareness and information about future markets among farmers. It is also essential to improve infrastructure such

⁵ The Government permits export of gram (chickpeas), 10,000 MT per annum of organic pulses and lentils, and roasted gram (whole/split) in consumer packets up to 1 kg

as grading and storage facilities, and electronically linked warehouses. All this will go a long way in making the objectives of E-NAM (the electronic platform which networks existing mandis) – of creating a unified national market for agricultural commodities – succeed.

Intriguing gram inflation

The vertical take-off



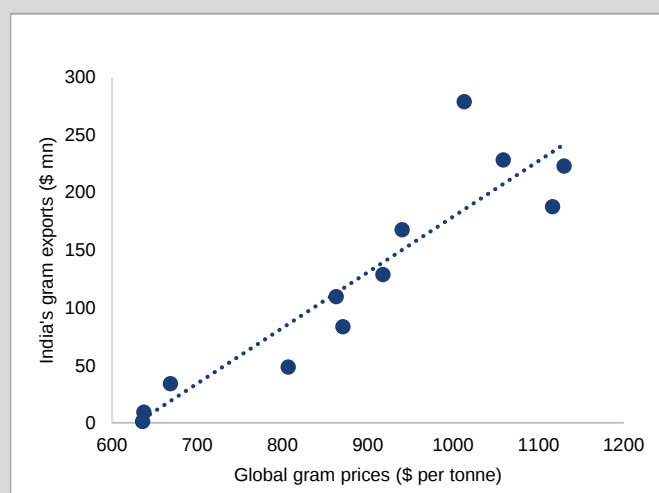
Source: Ministry of Industry, CEIC, CRISIL Research

For more than a decade now, gram prices have seen a steep escalation. Average WPI inflation in gram rose to nearly 22% in the past six years, up from 8% in the preceding six years. The increase has also been accompanied by a pronounced rise in volatility in inflation, especially in the last five years. It is difficult to ascertain a reason for the increase in volatility, but what's known is that gram is subject to high seasonality as well as high price-cyclicality.

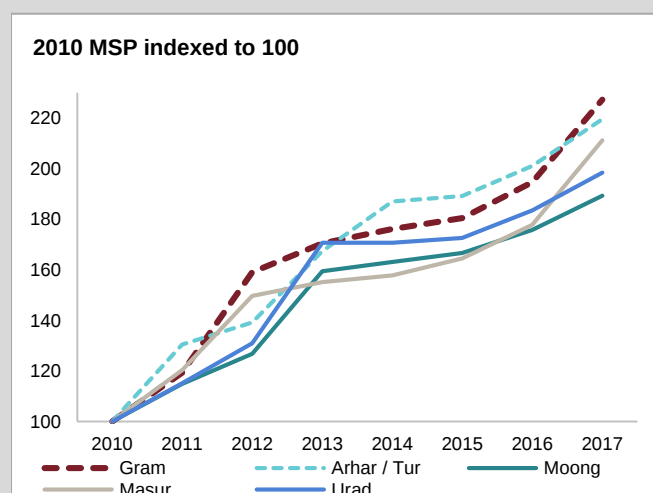
Gram has become an important produce with a production share of 40-45% in pulses (up from 39% 12 years ago) and an export share of over 60%.

Among pulses, the steepest price increase of late has been in gram. Two factors explain this – a sharp rise in both international prices and minimum support prices of the commodity.

Higher international prices and rising exports



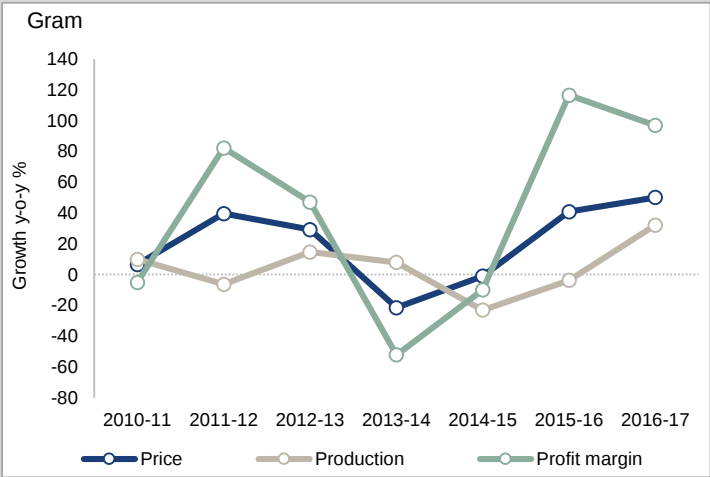
Sharper increase in MSP



Source: FAO, Ministry of Commerce and Industry, Ministry of Industry, CEIC, CRISIL Research

It is interesting to note that gram was the only pulses crop where there were no export restrictions. Crop growers could, therefore, benefit from both higher global prices (by exporting) and higher domestic MSPs. This ensured profit margin on gram nearly doubled in 2016-17 from 2015-16.

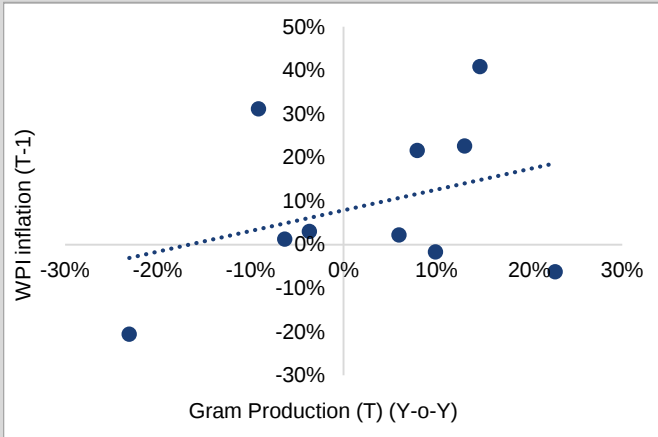
The exception of gram



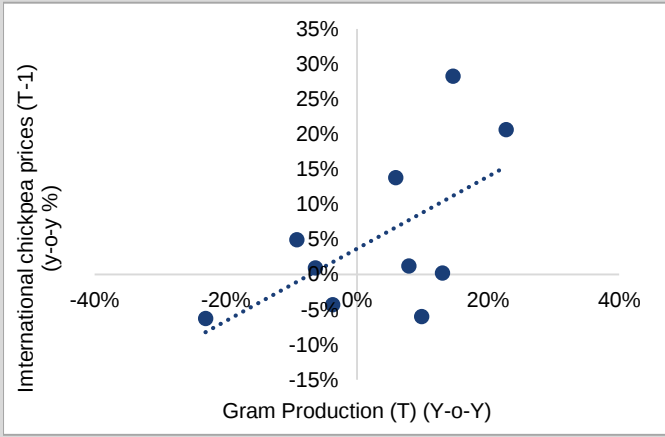
Source: DAC&FW, DCA. Years refer to AY

But unlike other pulses (as shown in earlier sections), the cobweb phenomenon is more prominent in gram for international prices compared with domestic prices. While there exists a weak positive correlation (coefficient of correlation = 0.3) between production growth and lagged WPI inflation, a strong positive correlation (coefficient of correlation = 0.6) is witnessed between production growth and international prices of gram (chickpea).

Weak positive correlation (0.3) between WPI inflation and domestic production growth



Strong positive correlation (0.6) between global prices and domestic production growth



Source: CEIC, Ministry of Commerce and Industry, DAC&FW, FAO

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